

Carbon dioxide from the Tropospheric Emission Spectrometer (TES) – analysis and preliminary results

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with comparisons to:

Comprehensive Observation Network for TRace gases by AIrLiner (CONTRAIL) CO₂
and

Atmospheric Infrared Sounder (AIRS) CO₂

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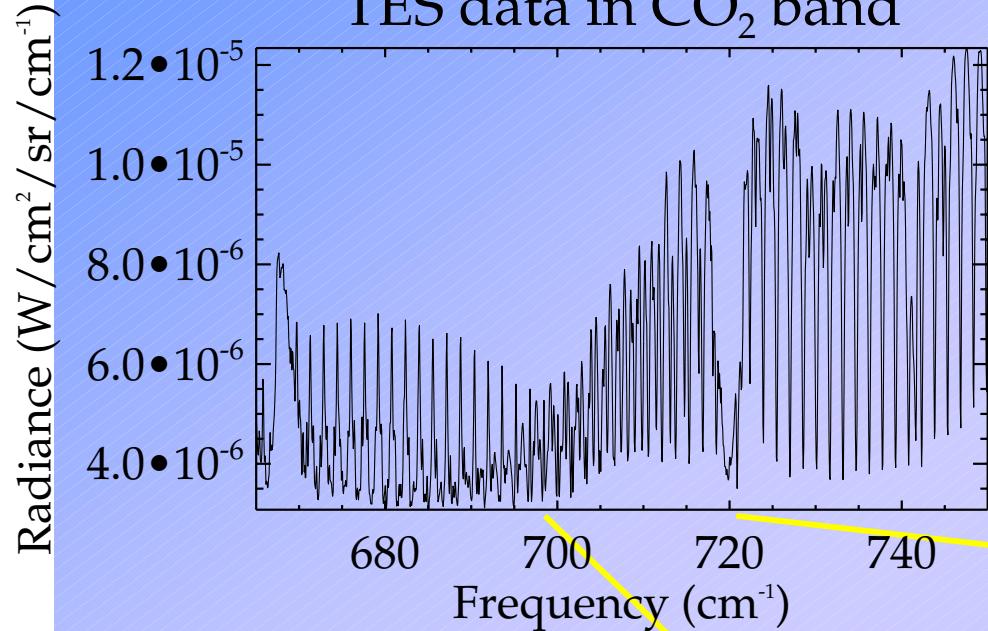


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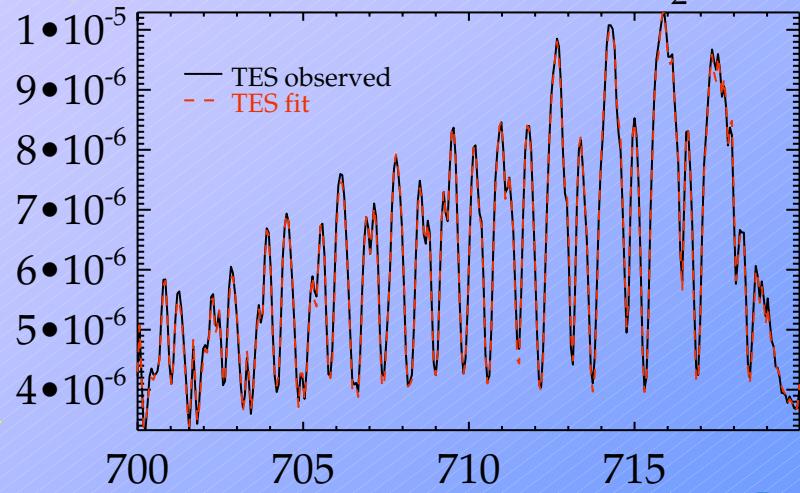
CO_2 spectra observed by TES

TES data in CO_2 band



- TES shows strong CO_2 signature
- TES forward model fits observed data (below)

TES observations in CO_2 band



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Method

- Strategy**
- Ocean, low cloud scenes
 - What to retrieve before and with CO₂



Constraint / window selection

- Use information content (Worden, 2004; Kulawik, 2006)



Validation and characterization

- Use Matsueda aircraft data
- Compare to AIRS



Assimilation studies

- Co-I Dylan Jones (University of Toronto)
- Assess added value; use GEOS-Chem



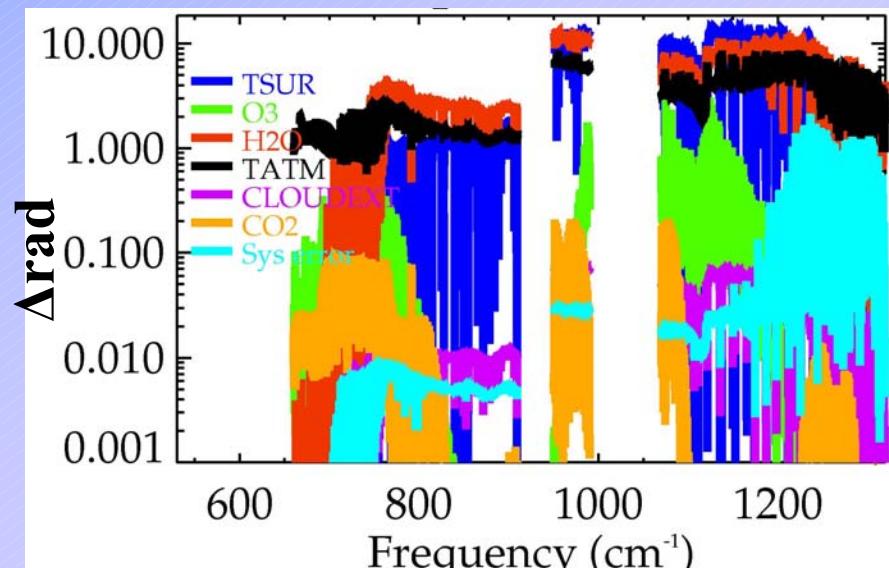
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“Retrievability” of a species

- Need sensitivity, variability, and signal to noise

$$\Delta r_{\text{rad}} = S_m^{-1/2} K \Delta x$$



- Initial T_{ATM} , H_2O , T_{SUR} , and O_3 impact on radiance overshadows impact of CO_2



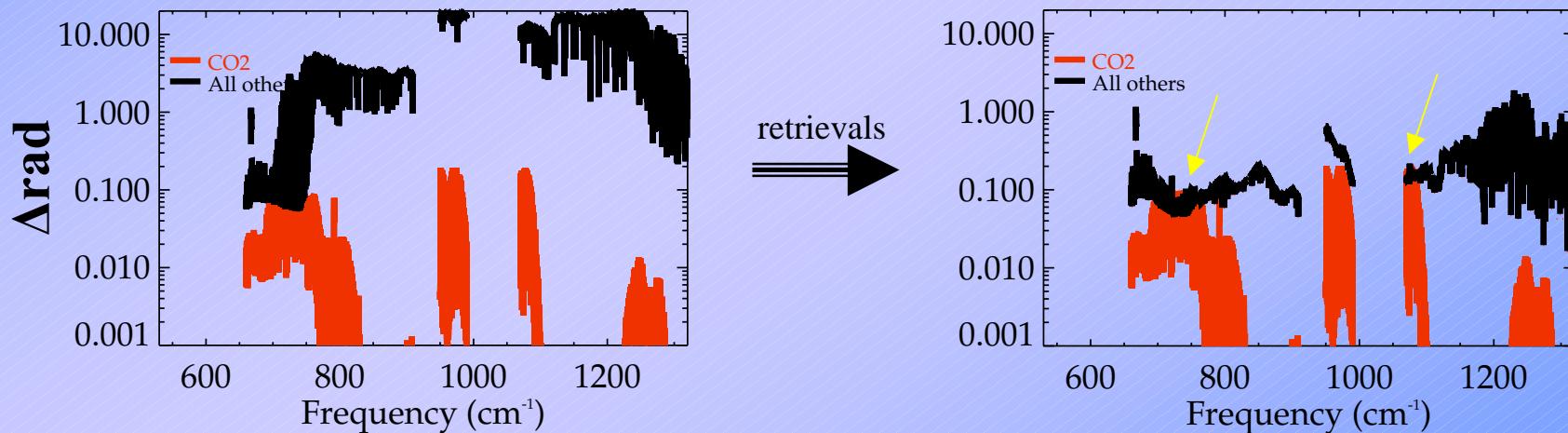
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Before & after T_{ATM} etc. retrievals

- Following retrievals of T_{ATM} , H_2O , etc., Δx is reduced, hence impact on radiance variability is reduced
- CO_2 retrievals now predicted to improve over *a priori* uncertainty



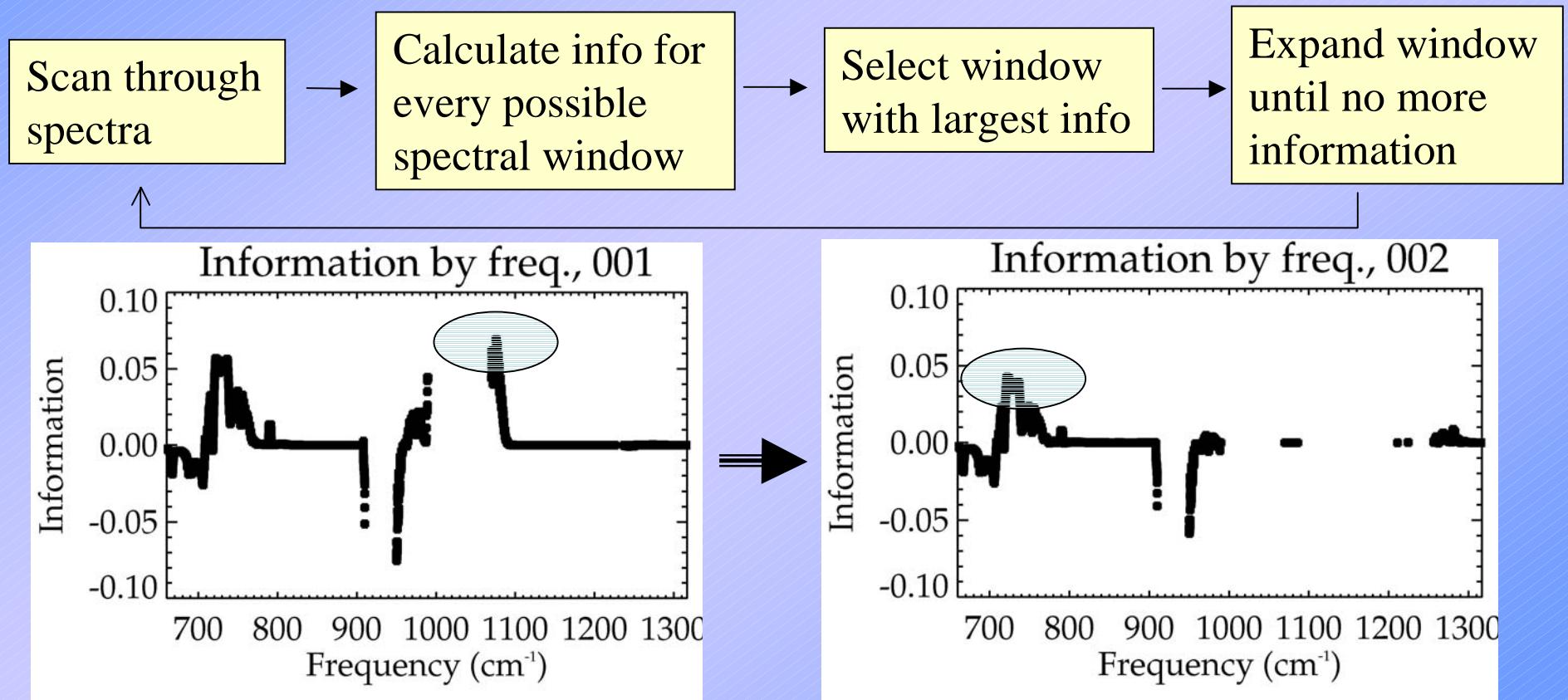
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Window selection – information content

$$\text{Information content} = \frac{1}{2} \log_2 \frac{|\mathbf{S}_{prior}|}{|\mathbf{S}_{error}|}$$



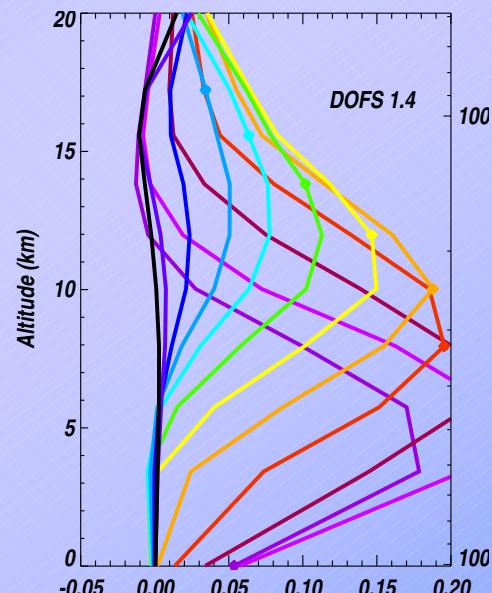
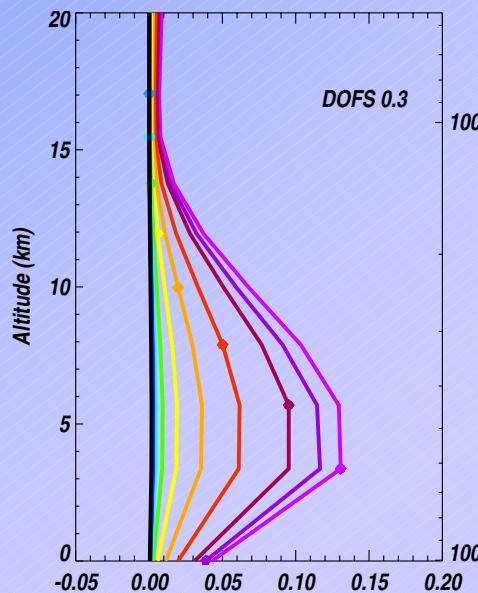
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Characterization

- Original analysis selected CO₂ windows in 10 um (1000 cm⁻¹) region



- Peak sensitivity for current windows at 600 hPa with 0.3 DOF

- 700 cm⁻¹ region in progress



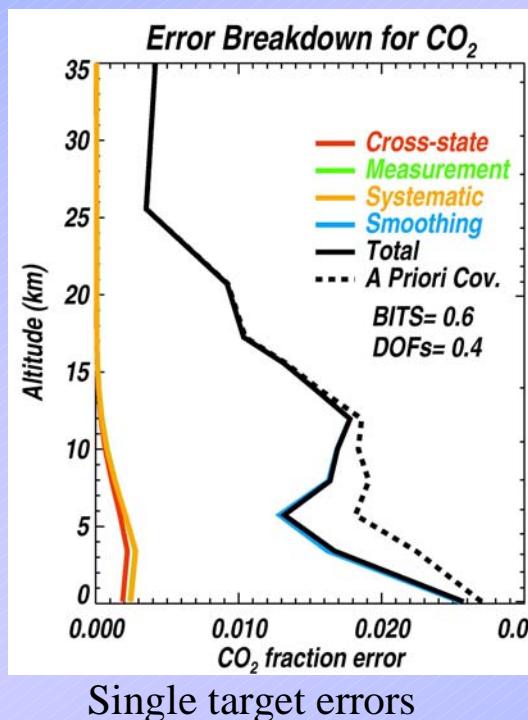
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Predicted errors and averaging

- Simple averaging – can improve all but smoothing error
- More intelligent averaging (e.g. information space) – also improves smoothing error and DOF



- About 2% variability (8 ppm) in TES results; indicates averaging 20 profiles for ~2 ppm errors.

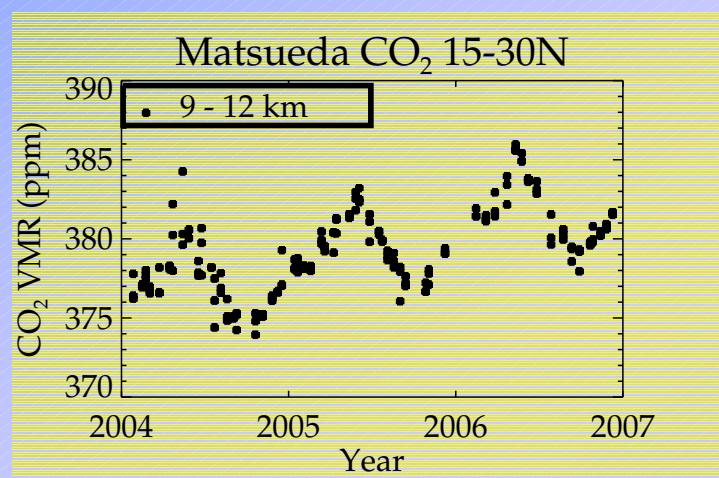
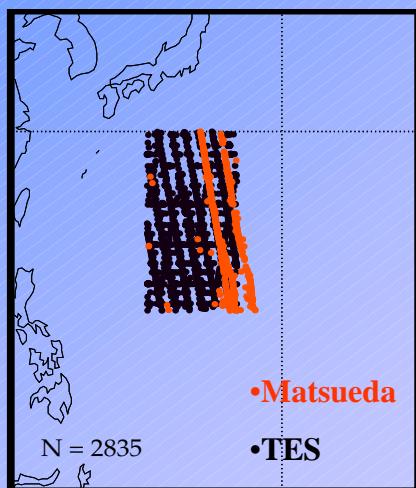


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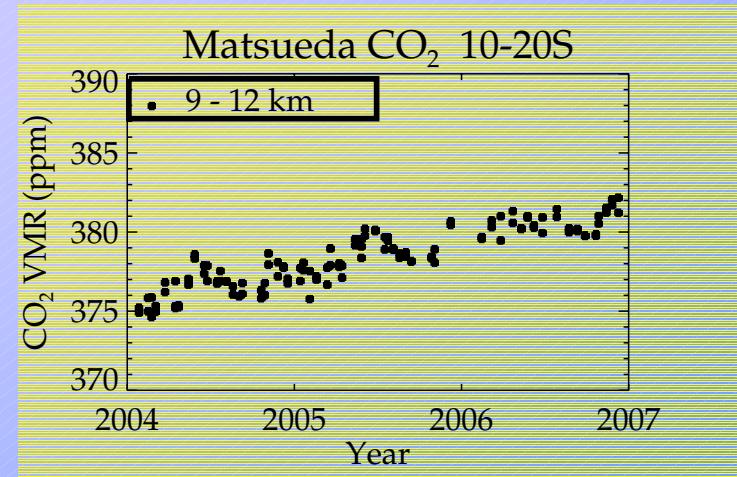
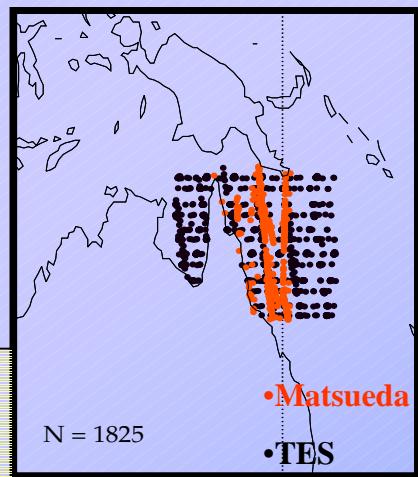
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Comparisons to Matsueda aircraft flask data* and AIRS



N. Hemisphere -
Strong seasonal variability w/ upward trend

S. Hemisphere -
Constant upward trend



*Comprehensive Observation Network for
TRace gases by AIRliner (CONTRAIL)

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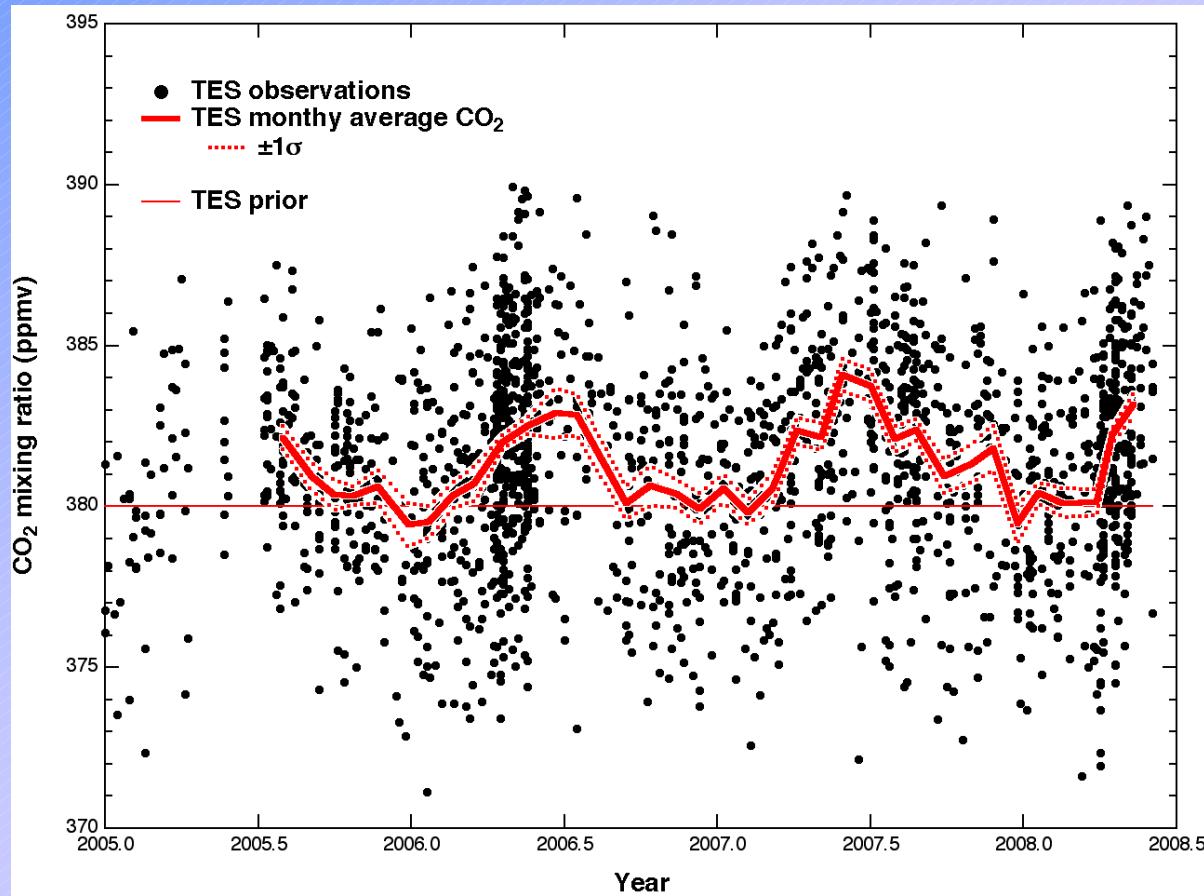


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TES results near Matsueda data 15-30N

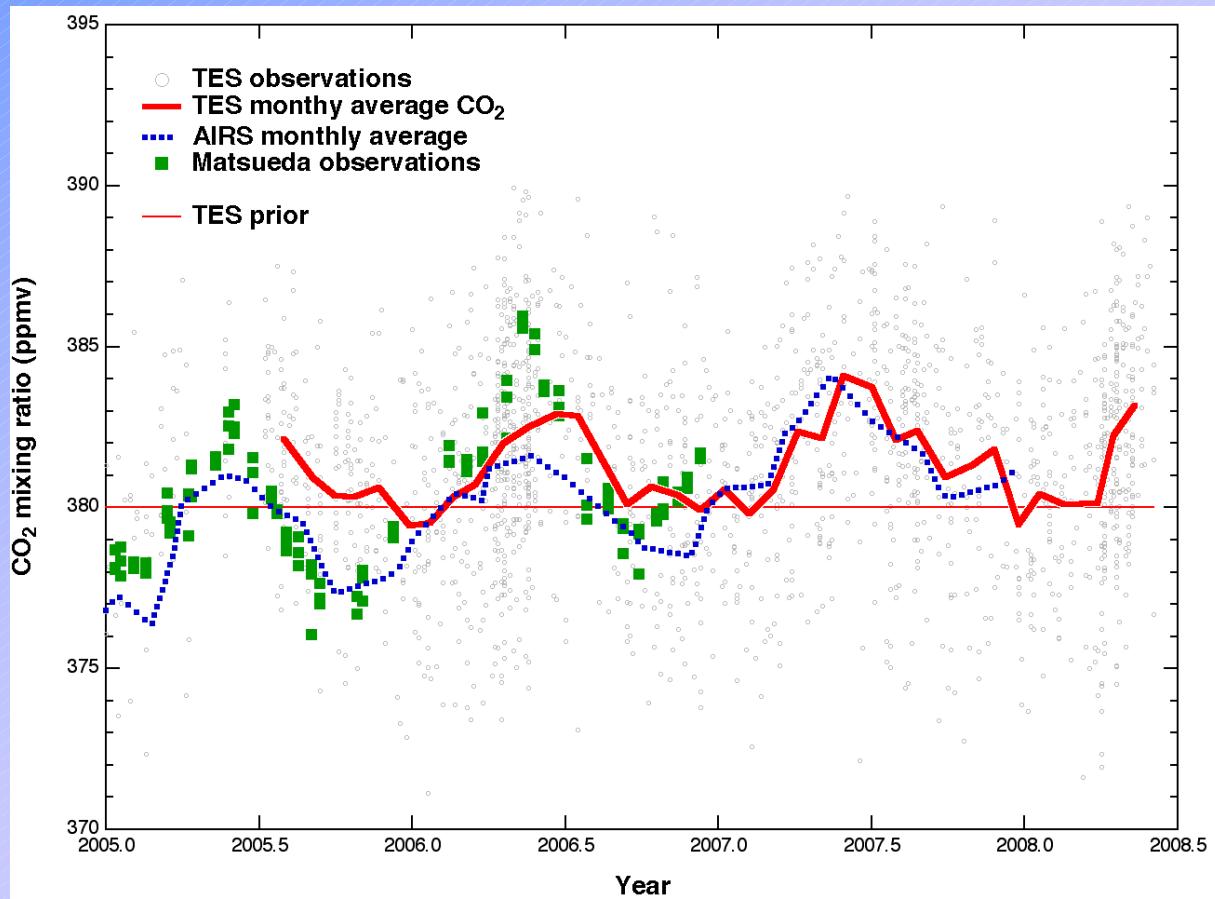


- TES at 618 hPa
- Initial guess & prior are constant, 380 ppm



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TES vs. Matsueda and AIRS, 15-30N

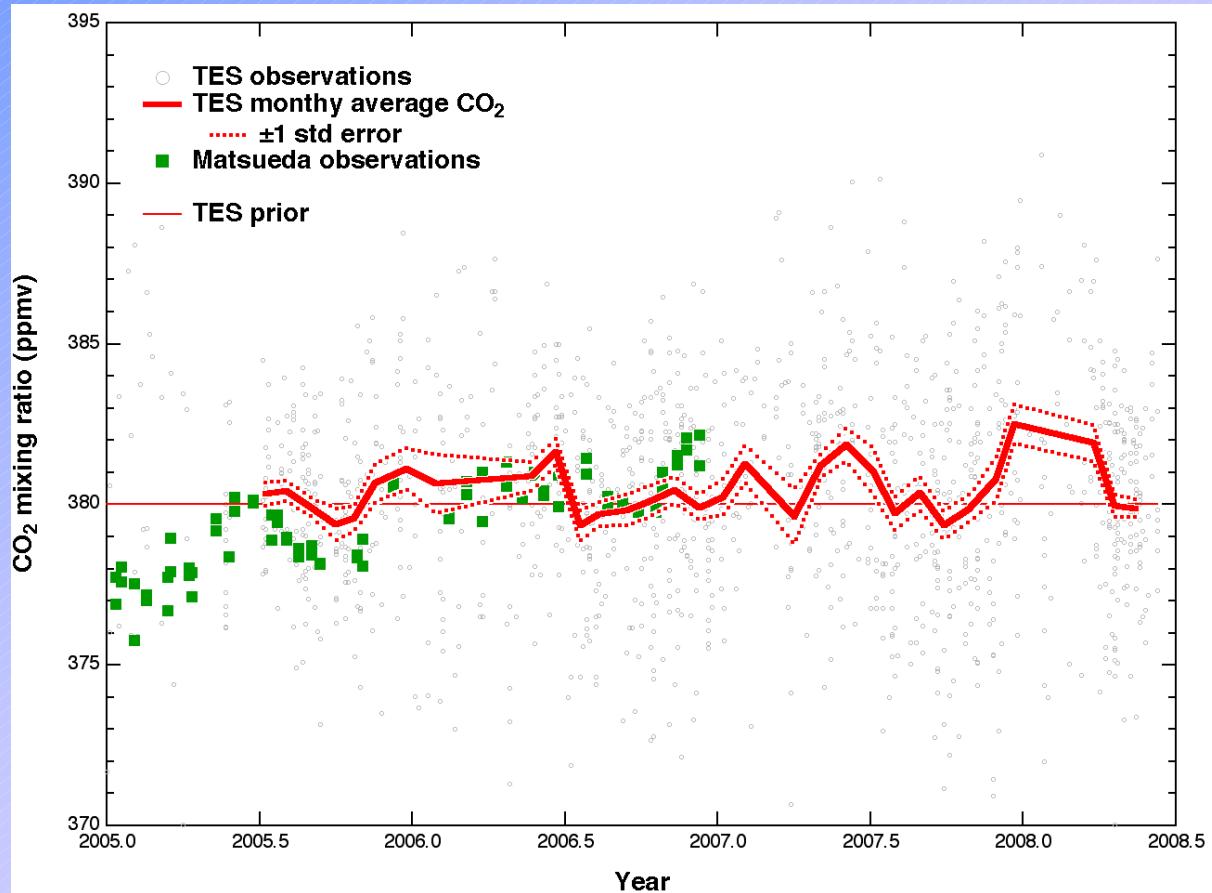


- Seasonal trends for TES monthly average, AIRS monthly average, and Matsueda data agree relatively well
- Yearly trends not seen



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TES vs. Matsueda, 10-30S



- Initial guess / prior are constant (380 ppm)
- No seasonal and/or yearly trends seen



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Conclusions

- Precision and propagated errors from other species are the primary challenges to successfully retrieving CO₂
- Developed a methodology to systematically characterize those errors
- TES CO₂ results are promising – developing approach to include 700 cm⁻¹ region
- Assimilation studies, global results next
- See poster by Kuai Le on combining CO₂ from OCO + TES

Thanks to AIRS team for CO₂ comparison data and to CONTRAIL flask data

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